ISSN 0717-3644
ISSN online 0718-221X

Maderas. Ciencia y tecnología 10(1): 61-68, 2008

CONSIDERING CHANGES IN WOOD UTILIZATION -A EUROPEAN PERSPECTIVE[1]

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ABSTRACT

Worldwide, continuous change is evident. What impact does it have on the utilization of wood? What should be considered when educating professionals in Wood Science and Technology (WS&T)? Where did we come from and where do we need to go? .Throughout history, forests provided important social, ecological, and economic values. Wood utilization advanced along with an unprecedented and exciting industrial evolution and WS&T became an interdisciplinary field. Recently, stronger environmental concerns and "globalization" impacted societies in major ways influencing timber availability, processing, and trade. Demand is growing for bio-energy, "green" chemicals and composites. CO_2 savings are to be made by using timber in construction. Globalization created entirely new business that communicate and network worldwide. Quality assurance for products and manufacturing increases in importance. Globalization demands interdisciplinary education in WS&T. While recognized as a material science, it must retain its identity and association with related industries. Undergraduate education requires a broad knowledge base, then specialized topics, and finally, integration of information with options available. Graduate programs are ideally tailored to background and professional needs of students, but thesis topics are best selected from faculty research. Bodies for accreditation of curricula may be wise to require a standardized core of subjects, but show flexibility.

Keywords: Wood science and technology, education, global change

THROUGHOUT HISTORY

Forests have provided for mankind important social, cultural and ecological values as well as a strong basis for economic development. Theophrastus (born about 390 AD in Greece) may have been the first to publish scientific thought on the anatomy of trees in his book "About the history of plants". In 14th century Europe, it was recognized that trees had to be managed to assure sustainability of forests. Over time, growing empirical knowledge became forest science. Finally, foresters became convinced that successful culture and sensitive care of forests required a body of knowledge integrated from basic sciences such as botany, chemistry, mathematics, technology, political science, and law. The first concepts of forest science, developed in the middle of the 19th century, included wood utilization. Soon a number of forest academies were founded in Austria/Hungary, Denmark, France, Germany, Poland, Russia and Sweden. Often, colleges fused agriculture and forestry under one roof for the purpose of academic teaching about the use of natural resources.

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Received: 02.01. 2008. Accepted: 24.02 2008.

In the USA, forestry programs originated at Cornell, Yale, and Land Grant Universities. The latter established a tradition of teaching, research, and extension. The need was to teach students practical relevant skills, especially at the undergraduate level. Original research, that also involved graduate students, was to lead to novel scientific findings. The knowledge was to be extended to practitioners as well as to experienced managers. Wood utilization research received a special impetus through the establishment of the Forest Products Laboratory, a branch of the US Department of Agriculture, in Madison, Wisconsin.

Programs in Forestry - now on all continents - grew together or along with those in Agriculture. Early wood utilization courses developed into Wood Science and Technology that had also been defined as an interdisciplinary field. Botany, chemistry, physics, and engineering, all focused on wood as a material, became the foundation. The key to this specialized knowledge were the interrelationships between anatomy on a macroscopic, microscopic, and ultra-structural level, chemical constituents, physical properties and transport phenomena, as well as process and structural engineering.

Obviously, forest industries expanded close to forests, the source of their raw material. Schools and research organizations often developed close to the industries to foster good relationships. During the last century, especially during the last 60 years, the utilization of wood advanced through unprecedented and exciting industrial evolution and expansion in many fields. A look back provides perspective on the progress in industry and academia during the last decades. The last IUFRO Division 5 Conference in 2003 "Providing for sustainable choices" and the Society of Wood Science and Technology Symposium in 2002 "Wood Science and Technology in North America: Reviewing our contributions and uniqueness" provide this picture. They recounted the development of new technologies and products as well as the relationship to academic programs. Just some of these developments (not including the field of pulp and paper) should be recounted:

Improvements in sawmilling equipment lead to the widespread use of chipping head-rigs and edgers as well as thin, high-strain band saws. Thin boards could be laid-up into large laminated beams or could be connected to trusses opening new possibilities for timber engineering. Engineering designs provided for greater security against earthquake and wind forces. Basic to all these advances became quality assurance concepts. Research on the relationships of sound transmission and vibration properties to stiffness and strength made possible the non-destructive testing of products, most importantly machine stress rating. Scanning techniques enhanced these methods, but most importantly lead to the computerized log breakdown, such as the Best-opening-face program. Now, computerized process control can be found in almost all types of manufacturing.

Advancement in log peeling equipment became the key to the growth of the plywood industry. The industrial production of plywood, in turn, initiated the widespread use of panels. The inventions of particle and fiberboards as well as flake and strand boards enlarged the options in this panel market for structural uses and the manufacture of furniture. But the key to composite products was the advancing knowledge of adhesion and adhesives. The type and quality of adhesives greatly influences the quality of bonding and thus, the quality of a glued product. While the basic chemicals, urea, melamine, phenol, resorcinol and formaldehyde have hardly changed, the way they have been enhanced led, together with improved production parameters, to shorter press times and better product performance. Enhanced adhesives made also possible combinations of wood with plastics, metals, and glass.

Early on, environmental concerns among the public called for a reduction of emissions during the production and the use of glued products and the elimination of wood preservation chemicals that were considered toxic to humans, animals, and plants. This provided a real challenge to come up with new means to manufacture products with long, satisfactory service life. In addition, environmental requirements led to environmental life cycle inventories and analyses. This assessment of environmental performance of products takes into account all the inputs and outputs of manufacturing and construction

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processes including raw material extraction, product and building use, maintenance and ultimate disposal. Called for were more recycling and higher energy efficiencies.

During this just described expansion period, industry worked, more or less, hand in hand with universities, as well as public and private research organizations in acquiring knowledge as a basis for improving existing or developing new products. They are now useful for housing and furnishing millions of people and advantageous for constructing not only efficient buildings, but also exciting and beautiful arenas. - In Europe, just a few years ago, forests represented only 5% of the world's forest cover, but the forest products industry supplied over 30% of world trade in wood and wood based products. Wood harvesting was, on an average, only 75% of the annual growth increment and the forested area was increasing. The move was towards the paradigm of sustainable development. This picture is not reflected in many other parts of the world where the forested area is often decreasing. Principles of forestry and forest utilization are often not or not fully appreciated.

ALL THINGS CHANGE

During the last 10 to 15 years elementary changes occurred around the world. Even stronger environmental concerns and "globalization" - to name maybe the two most important factors - impacted societies in major ways. Naturally, they also impacted our profession. They strongly influence timber availability, processing, and trade.

Environmental concerns

Are imbedded in the "Vision for 2030" of the European forest-based sector. It now calls for "a competitive, knowledge-based industry that fosters the extended use of renewable forest resources. It should strive to ensure its societal contribution in the context of a bio-based, customer-driven and globally competitive European economy." The vision is to lead to major contributions to society through the

- development of new and innovative products tailored to consumer needs;
- management of sustainable forests;
- reduction of environmental impacts;
- resistance against climate change and its effects;
- reduction of Europe's dependence on oil;
- participation in Europe's strategy for growth and jobs; and
- sustenance of employment, especially in rural areas.

Demand is also growing for a more active engagement in the bio-energy field. Indeed, "green" chemicals, novel composites, and the non-wood values of European forests have already been identified as opportunities. New concepts are hoped for that use wood to mitigate a possible climate change as all wood products are thought to 'lock up' carbon. Wood is to contribute also by providing substitutes for non-renewable materials in sectors such as packaging, fuels, chemicals and construction. In manufacturing, development is needed of intelligent and efficient processes, including reduced energy consumption.

Work is currently underway across Europe to develop new markets and new products for recovered wood, including wood-plastic composites; animal bedding; filling material for compost; charcoal production; surfacing as mulch pathways, playground surfaces etc. Only high quality recovered wood can be used in these applications, in order to safeguard the health of all 'consumers' involved. The forest-based industries consider recycling to be an integral part of producing sustainable products and are attempting to increase the recycled content of products. Quality standards limit the permissible amount of impurities to ensure that wood-based panels are safe and environmentally friendly, regardless of whether they are produced from recycled or virgin wood material. Industry standards are based on the European standard for the safety of toys.

The production of usable energy from biomass needs market introduction and optimization of biomass combustion technologies. Obviously, the wood industries themselves are major users of biomass energy. They generated this energy by using timber fractions that could not be converted to products. Now it appears that subsidies given to power plants that combust biomass for energy may create unfair competition between them and plants that use such raw material for products such as composition boards and pulp. In a number of European countries, charging consumers a special eco-energy tax finances such subsidies. The industry advocates that forest-based materials should be effectively utilized according to the "cascading principle": First, the structural properties of wood are to be utilized to create new products, then recovered materials are to be used for recycled products, and eventually, material that is not economically viable for recycling is to be made available for energy.

The production of bio-diesel and ethanol from agricultural matter increased considerably during the last year. During the growing season of 2005/6, Europe produced about 4.6mill.t of bio-diesel versus 1mill.t for the USA. On the other hand, the USA by far out-produced Europe with 19.1mill.t of ethanol versus 1.6mill.t. In the future, with new technologies coming on line, wood may become a desirable raw material.

The forest-based industries pointed to significant CO_2 savings to be made by using timber in the construction of housing and other buildings, both in terms of embodied energy and in-use energy efficiency. While there are different timber frame and solid timber structures across Europe, generally, higher wood content relates to lower embodied energy of the building. A combination of a thermally efficient lightweight wood frame with a high thermal mass concrete or stone core has been recommended to achieve the most effective insulation along with minimal day-time/night-time temperature fluctuation. Considering the growing importance of energy-efficient building methods, timber construction will play an increasingly important role in the future.

The desire to comply with the Kyoto Protocol, which went into effect in 2005, led to the emergence of a new market, trading monetary value of carbon sequestration consequential to afforestation programs. Carbon market prices for emission reductions and CO_2 emission allowances have been projected to range between 15 and 30 €/tones of CO_2.

Environmental concerns have also forced industry and trade organizations to improve their environmental image. While efforts are made, especially in Europe, to strengthen consumer perception of wood as a desirable, natural material, harvesting and trade of timber, particularly in tropical areas became restricted.

A good example is the proposed Timber Trade Action Plan of the European timber trade associations that aims at stopping illegal logging mainly in tropical forests. This plan suggests the establishment of chain-of-custody systems not only to verify the legality of traded timber, but also to ensure that members comply with environmental baseline criteria. This calls for careful timber sourcing and evaluating of suppliers and product declarations chiefly from so called controversial countries. A suggestion has been that all member companies be monitored regarding their environmental commitments. Both Governmental and Non-Governmental organizations are to consult in establishing environmental codes of conduct and responsible purchasing policies. The suggested code of conduct has the common objective "to trade in legal and preferably sustainable timber only" linking the issues of illegal logging to timber certification. It outlines conventional principles and expectations that should be considered binding on any member of the association or industry group. An aim is to harmonize purchasing policies of European trade organizations as well as public sector timber procurement policies. Presently, there still are differences, but some similarities among European states and only few European governments promote public purchasing policies.

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Further, there is a strong desire to conserve the biological diversity of forests and manage them accordingly. Thus, a small, but increasing portion - about 11% - of the world's forest is now dedicated to that goal.

GLOBALIZATION

The term reflects the appearance of entirely new businesses and partially new social and political patterns. It describes the changes how people communicate worldwide, organizations network, and business and governments relate to each other. Globalization has changed the marketplace requiring many companies to adapt or fail.

Personal computers enabled individuals to obtain, manipulate, and create information in digital form. Digital versions of data, words, pictures, and music are now distributed via modems connected to the world wide telephone systems. The World Wide Web enables the creation, organization, and linkage of documents over the Internet. Hypertext links, such as *html,* allowed connections via the Web. Browsers made it possible to surf the Web. Now companies can create, analyze, and transmit data for manufacturing, inventories, marketing, sales, and billing. Anyone can become a buyer or seller when using the appropriate software program. Web-based business organizations access complex business applications with a simple browser. A manufacturing process can be taken apart and individual tasks send around to whoever can do them best, or cheapest, or both.

Information technology has become a large investment for many companies, also for those in the forest products field. A real-time data warehouse functions as a corporate memory, a repository of its technology. Real-time databases store production data that can be mined and used for advanced analysis. Such analyses are commonly based on statistical methods such as multiple linear regressions for approximately homogenous populations; decision tree models for examining complex relationships between different types of data; as well as genetic algorithms and neural network modeling. Real-time monitoring and decision making software is usually proprietary and useful for quality control, preventive maintenance and servicing jobs in a plant or a secure online connection.

Political actions also facilitated globalization. The various trade-rounds and the establishment of the World Trade Organization made a huge contribution to liberalizing world trade. In addition, shipping and transportation in general became reasonably priced. All these factors had a profound effect on forestry and forest products enterprises. The demand for forest products has been increasing and global trade flows changing. Producers are now shipping goods to markets much farther away from locations of manufacture. This is reflected in recent statistics of the relevant organizations of the United Nations.

For instance, China has become the largest trader of wood products worldwide and continues to increase its production. It mainly imports raw materials and exports finished wood products. In 2006, its trade balance in forest products was greatly positive: The total import value was US$19.39 billion and exports amounted to US$27.68 billion. Of the imports, pulp accounted for 25.7%, logs for 20.3%, and lumber and panels 11.9%. Of the exports, wood furniture was 31.7% and other solid wood products, incl. plywood, 23.7%.

Quality assurance for products and their manufacturing is increasing in importance with the increase in world trade. The European guidelines for building products, the basis for certifying quality, CE-marking, are now generally used for certification of product quality in Europe. The European Norm (EN) prevails and efforts are made to harmonize requirements with the standards of the International Standard Organization (ISO). Significant differences still exist to the standards of the American Society for Testing and Materials (ASTM), to some extent because of differences in measuring systems.

Globalization progresses in education

The Bologna Declaration of June 1999 put in motion a series of reforms needed to make European Higher Education more compatible and comparable, more competitive and more attractive for our own citizens and for citizens and scholars from other continents. Twenty-nine European countries pledged to reform the structures of their higher education systems in a convergent way. Two most important objectives specified were:

- The adoption of a common framework of readable and comparable degrees;
- The introduction of undergraduate and postgraduate levels, with first degrees no shorter than 3 years and relevant to the labor market.

In May 2005, the Ministers of Higher Education of the Bologna Signatory States confirmed the degree system, quality assurance and recognition of degrees and study periods. They adopted a framework for qualifications comprised of three cycles, generic descriptors for each cycle based on learning outcomes and competences, and credit ranges in the first and second cycles. Basically, three years of higher education at the undergraduate level lead to a Bachelor - quite in contrast to four years in North America and elsewhere. Additional two years at the post-graduate level lead to a Master degree. Next to the need to "achieve greater compatibility and comparability in the systems of higher education" (mainly an intra-European issue), the Declaration wants "in particular" to increase "the international competitiveness of the European system of higher education". It says that the "vitality and efficiency of any civilization can be measured by the appeal its culture has for other countries". The signatory countries explicitly expressed their goal to "ensure that the European higher education system acquires a worldwide degree of attractiveness equal to [Europe's] extraordinary cultural and scientific traditions". The ministers committed themselves to elaborate national frameworks for qualifications compatible with the overarching framework for qualifications by 2010.

WOOD SCIENCE AND TECHNOLOGY EDUCATION

Will be needed in the future. The field is now recognized as a material science. But it is an interdisciplinary field and must retain its identity to retain its association with its related industries and its traditional support from strong agricultural and forestry groupings. Educators always remain aware of the basic need to get students into jobs and especially into good professional positions. They are challenged to bridge the gap between the academic classroom and the more practical professional development. They must gain and/or maintain acceptance for Wood Science and Technology as specialized and valuable profession by employers as well as leaders in universities and public agencies. They must be seen as providers of scientific and technical information. For this reason and as a basis for graduate education, a strong research program is necessary in most cases.

Students need an image of professional opportunities. Universities can not be inviting, if the industry is not attractive. Obviously, when universities attempt to attract students to their programs, the support of industries, their associations, and public entities as well as individual professionals can be very valuable. On the other hand, universities must recognize what knowledge and skills are needed by the industry. In general they are:

- A scientific core;
- Computer literacy;
- Mastery of languages - including ones own;
- Ability for teamwork and cooperation;
- Desire for networking and life long learning.

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Academic requirements are determined, in general, by institutions based on quality standards and/or by governments in response to industry needs and traditions. Among independent professional groupings, the Society of Wood Science and Technology established probably the most comprehensive scheme that has been applied in conjunction with an accreditation procedure.

A few additional thoughts may be submitted on this subject: For an undergraduate curriculum, it seems, three educational phases are desirable: First a broad knowledge base should provide students with a broad understanding of the profession; then specialized topics must be taught; and finally, in the last year of study, integration of the provided knowledge should take place. Options should become available during the second and third phase:

1. During the early part of studies, an interdisciplinary base can be established by linking, on the one hand, botany to environmental sciences and forestry, and on the other physics and chemistry to material science with emphasis on physical properties and strength of materials. Information technology, statistics and economics are other basic building blocks. To establish such a base, some team teaching may be called for.
2. The second phase focuses more narrowly on wood products, their manufacturing processes, and trade. Here, some emphasis is to be placed on quality assurance and testing methods. Preferred options might be selected in fields such as business, industrial engineering, and structural engineering or similar.
3. The later part of undergraduate studies is to integrate related subjects.

Masters programs are ideally tailored to the background and professional needs or aspirations of students. A graduate student who wishes to enter industry, for instance, would want to research a "real world" problem, while a person to go on to a purely science based PhD program may need to focus on more scientific subjects. Flexibility is necessary because faculty members need to select thesis topics related to their research topics and funding. Generally, there will be more "problem solving" than "curiosity driven" research.

Master's programs should be available to students with other professional background as well, provided that a core of Wood Science and Technology courses are taken and the thesis linked to the student's background. For instance a student with a bachelor degree in forestry or genetics might link ones knowledge to tree biology and wood properties.

Bodies for accreditation of curricula may be wise to require a standardized core of subjects, but show flexibility when recognizing related, often optional course work. A tricky question to answer is what difference, if any, exists between a bachelor degree requiring three to one requiring four years of study.

CONCLUSIONS

In looking at the discussed topic, one should conclude: Wood Science and Technology can be proud of the past and hopeful for the future.

NOTE

[1]Presented at the International Union of Forest Research Organizations (IUFRO) Division 5 Conference in Taipei, Taiwan, November 2007.

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